STATUS, ECOLOGY AND BEHAVIOUR OF NARCONDAM HORNBILL (*ACEROS NARCONDAMI*) IN NARCONDAM ISLAND, ANDAMAN AND NICOBAR ISLANDS, INDIA[1]

(*With three text-figures*)

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Key words: Narcondam hornbill, *Aceros narcondami*, Andaman and Nicobar Islands, status, behaviour, habitat, feeding, nesting, conservation

Narcondam Island is part of the submerged lines of hills which constitute the Andaman and Nicobar (A & N hereafter) Archipelago in the Bay of Bengal (Abdulali 1971). The Narcondam hornbill *Aceros narcondami*, endemic to Narcondam Island, is an interesting species from the ecological and evolutionary point of view, and is also a Red Data Book (RDB) species (King 1981). It has been declared endangered due to its restricted range (Stattersfield *et al.* 1998). The Island was recently declared an Important Bird Area (IBA) under the IBA programme launched by Birdlife International and the BNHS in India. Considering the isolation of this important species and scanty information on its ecology and biology, a short-term study was conducted in March 2000. Line transect method was adopted for population estimation. Observations were carried out to collect data on behavioural aspects like feeding, pre- and post-roosting behaviour, nesting, vocalization and interaction with other species. Circular Plot and PCQ method were used to estimate the tree density. Around 432 birds were estimated to be on the Island. Population density estimate using line transect was 72 birds/sq. km. Twenty active nests were recorded. Though the present population seems to be stable, the confinement of the hornbills on such a small island makes them vulnerable to intrinsic and extrinsic threats.

INTRODUCTION

Island life exhibits features of special interest. The sea is a barrier to its colonisation by terrestrial life forms, but the species that are once established frequently develop new features in their isolated surroundings. A long established sea barrier results in marked differences between the animal and vegetation even of adjacent islands. India has a number of islands both in the Bay of Bengal and Arabian Sea, the former being much larger and more habitable. The islands in Bay of Bengal represent submarine mountains, while the islands in the Arabian Sea are entirely built by corals (Singh 1920).

The Narcondam hornbill (*Aceros narcondami*) is an endemic bird. Scanty information is available on its population, ecology and biology, due to the remoteness of its home, Narcondam Island. There are records of only seven to eight visits, of not more than five days, between 1873 and 1984. Prain (1893), Cory (1902), Osmaston (1905) and John (1889) are few records of the species. Hussain (1984) and Ravi Sankaran (pers. comm.) in 1998 spent 1-3 months. Kemp (1995) has summarized information and Ravi Sankaran (pers. comm.) has discussed the current conservation problems of this vulnerable species. A rough estimate given by Ravi Sankaran indicated 290-320 birds. Apart from these, there is no other comprehensive study on the biology and ecology of the Narcondam hornbills. Thus, the present study was conducted to assess the present status, ecology and behaviour of this isolated species.

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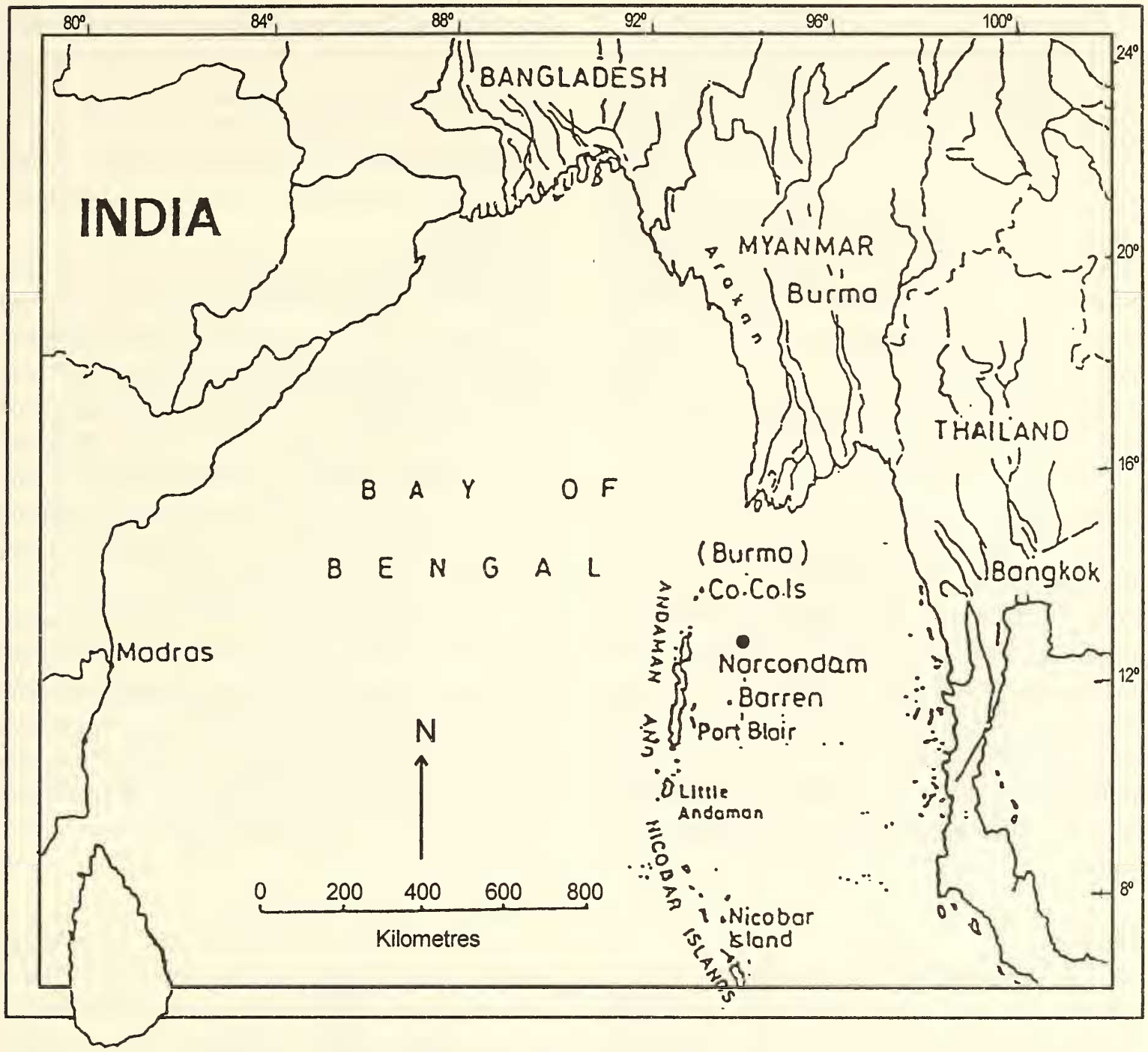

Fig. 1: Location Map of Narcondam Island

Hornbills (Bucerotidae and Bucorvidae) are a group of large, forest and savanna birds restricted to the Old World tropics. There are 54 species of hornbills in the world (Kemp 1988), nine of which occur in India (Ali and Ripley 1970). Only in the last decade, some studies provided valuable insight into the ecology of these unique cavity-nesting birds (Mudappa 2000). The Indian hornbills are secondary cavity-nesters, largely forest dwelling species and predominantly frugivorous (Kemp 1976).

Study Area

Narcondam Island is one of the 323 islands of the Andaman and Nicobar Islands, which lie in a long and narrow broken chain, approximately north to south, sprawling like an arc, and having an area of 8,293 sq. km. Around 80% land area is under forest cover. Narcondam Island (13° 27' N, 94° 17' E) lies about 114 km off Port Blair towards Myanmar (Fig. 1). It lies about 500 km off the Mergui Archipelago and about 300 km southwest of the Gulf of Martaban

in Myanmar (Kemp 1995). It is logical to presume a former connection from Cape Negris at the southern end of Burma to Achin Head (Cape Pedro) in Andalas (Sumatras) (Osmaston 1905)

The Island is an outcome of volcanic actions from the Sunda group, and lies, with the Nicobars, along one of the principal lines of weakness in the earth's surface. Wadia referred to it as a craterless volcano composed wholly of andesectic lava (Abdulali 1971). The total area is approximately 6.8 sq. km, and the highest peak is about 750 m above msl.

Legal status

The Island was recently declared a Wildlife Sanctuary under the Wildlife (Protection) Act 1972. It falls under the jurisdiction of the DFO, Mayabunder in the North Andaman. It was uninhabited until 1969, when the Government of India made a lookout post. A party of 17 police personnel is deputed on the Island for three months by rotation. A lighthouse has recently been constructed on the southern edge of the Island.

Climate

The climate of the Andamans group of Islands is tropical wet and humid, with daily temperature ranging from 27.8 °C maximum to 21.8 °C minimum. The Island receives both southwest and northeast monsoons, from May to October. At times, cyclonic storms occur during this period, with rough weather conditions almost throughout the season. The average annual rainfall recorded for the Island from the nearest weather station at Mayabunder is 3,055 mm, with an average of 134 rainy days/year. July records the highest and March the lowest rainfall.

Vegetation

Prain (1893) described some aspects of the flora of Narcondam (Hussain 1984). The flora of the Andaman and Nicobar group of Islands has been described in detail by Parkinson (1923) and Thothari (1960). The Island bears several generations of old, dead and decaying trees, interlaced with thorny creepers and luxuriantly flowering tall trees. The vegetation can be divided into littoral, deciduous, evergreen and moist evergreen.

The flora on the highest zones of the hill are mostly evergreen trees such as *Dipterocarpus*, *Sideroxylon* and *Ficus*. However, some deciduous species (e.g. Semul *Bombax insigne*) are also seen. The vegetation towards the summit is mostly moist evergreen with several epiphytes. The lower hills following the shoreline have both deciduous and evergreen trees like *Terminalia catappa*, *T. bialata*, *Parishia insignis*, *Caryota mitis* and several thorny creepers.

The shoreline has some introduced species such as coconut and banana. Apart from the introduced species, we could identify *Sterculia religiosa*, *Barringtonia speciosa*, *Thespesia populnea*, *Pandanus*, *Scaevola koenigii*, *Ipomea biloba* and *Hibiscus tiliaceus*. Good timber species also occur on the Island.

Campsite and its environs

The police camp area is very picturesque and is located on the eastern side of the Island. A considerable area has been transformed into a kitchen garden, with introduced plants, including about 25 varieties of vegetables and fruits. Some of the introduced species are growing like weeds. Remarkable among them is Tulsi (*Ocimum* sp.), which can be seen in thick patches almost on all sides of the camp. It has also started invading the upper areas of the forest. Several trees of *Ficus*, *Terminalia catappa* and a small mangrove patch were also seen.

Methodology and Analysis

The Line Transect Method (Emlen 1971) was adopted to estimate the density of Narcondam hornbills. The computer program

TRANSECT was used to analyze the data. The program calculates density of objects at three cut points and generates 95% confidence interval for each estimate (Burnham *et al.* 1980). We also calculated the density manually by the following formula

$$D = n / 2LY$$

where D = Density, n = No. of sightings, L = Total length walked and Y = Average perpendicular distance

Feeding at the nest by males was studied by shifts of observations on three nests, and three complete days were spent on each nest. Food items were identified by direct observation of fruiting trees and indirectly from the debris collected from the base of the nesting trees. Seeds collected from the midden were catalogued.

Density of fruiting and nesting trees was estimated by taking 10 m circular plots. The general tree density of the study area was assessed by the Plot Circular Quadrat Method (PCQ). Plants of height greater than 5 m were considered for this purpose. A herbarium of tree species was collected and identified with the help of scientists at the Botanical Survey of India, Port Blair.

Active nests were located by following the breeding males, and by checking signs of the previous year's fecal remains (midden) at the base of nest trees. At times, begging calls of the young hornbills being fed by the males also helped in locating active nests. A wooden boat was used for observations along the periphery of the Island. A hide was constructed at Nest No. 2 for regular observations and photography.

RESULTS

Population, status and distribution

The density of the hornbills was calculated as 72 birds per sq. km. Considering the effective hornbill habitat (6 sq. km), about 432 birds occur on the Island. However, a density of 83 hornbills per sq. km was estimated by the Fourier Series Estimator; percentage coefficient of variation was 8.9, lower limit 75.53 and upper limit 87.95.

The hornbills are almost uniformly distributed on the Island, with no preference for any landscape feature. Fig. 2 shows the number of sightings in each group of perpendicular distances. Most of the encounters were between 10-30 m of perpendicular distance.

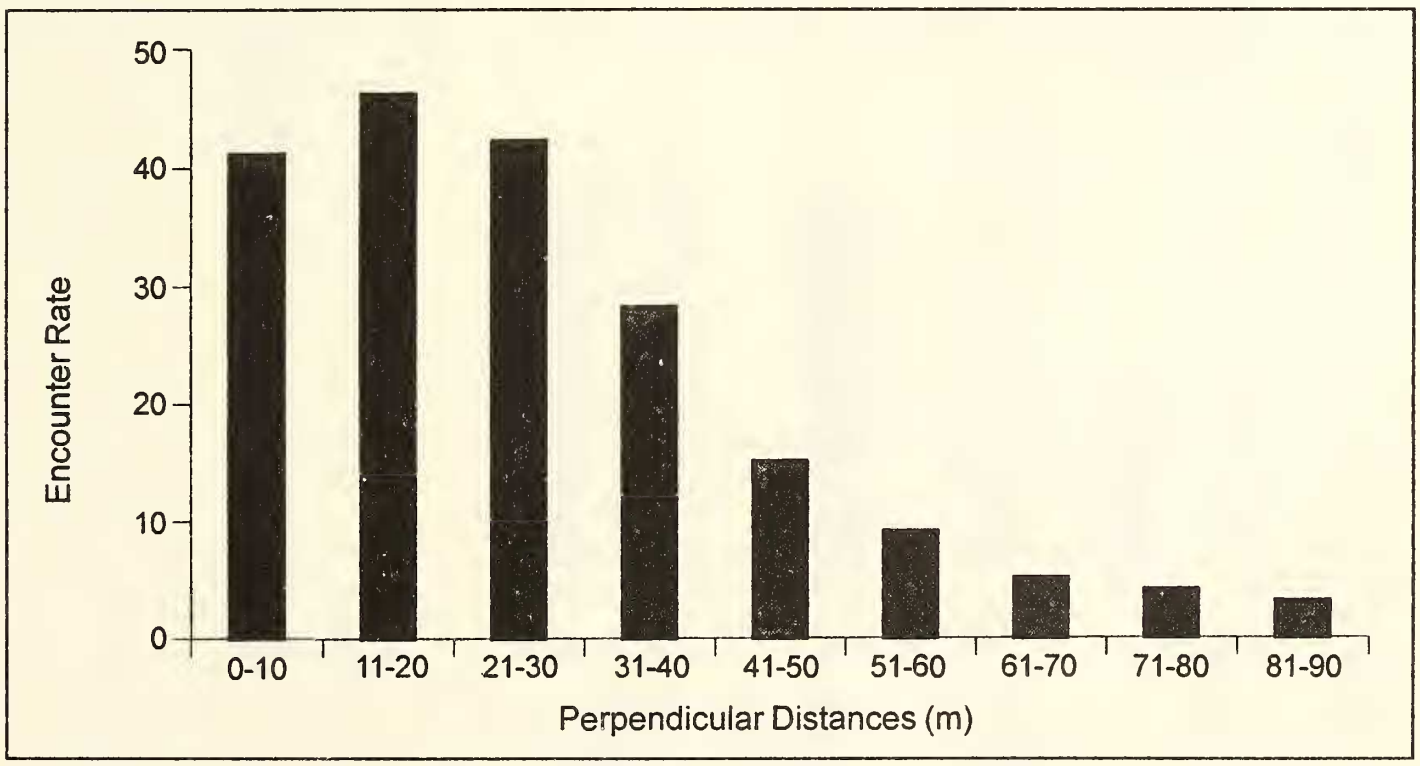

Fig. 2: Number of sightings in each group of perpendicular distances

Nest site characteristics and distribution

There is no apparent preference for a particular tree species for nesting (Table 1). Nests were recorded on slopes, in valleys and on ridge tops at different altitudes. Nests were predominantly found in trunks of living trees, some were also seen in partially dead tall trees. Nest height varied from a minimum of 3 to 35 m in the recorded nests, however, most of them were 10-20 m high (Table 1). One unusual nest was recorded in the main trunk of a very thin tree about 5 m above the ground.

The shortest distance between two nests was 8 m. Other bird species also nested near the hornbill's nest: one nest of Alexandrine parakeet (*Psittacula eupatria)* was just one metre above the hornbill's nest on the same tree, while another nest of the olive-backed sunbird (*Nectarinia jugularis*) was 4 m away.

Most hornbill nests were found facing east or west. Nest cavities of hornbills are probably used year after year, as evidenced by the remains of an old *machan* (Platform) near Nest No. 2, which was used by Sankaran in 1998. Nests were almost uniformly distributed on the Island, irrespective of altitude or other difference in microhabitats and there was no clumped setting. We found nests even just below the summit of the Island (645 m above msl, Table 1).

Tree density

A total of 9,420 sq. m area was sampled to estimate the fruiting and nesting tree density. 102 fruiting trees were recorded in sampled plots, giving a total density of 1,080 individuals per sq. km. Only 21 nesting trees were recorded in the same area and their density was calculated to be 222 trees per sq. km. However, the general tree density was 5,160 trees per sq. km from a sample of 50 circular plots.

Behavioural observations

Nest feeding: The incarcerated adult female and nestlings are dependent on the male for providing food. A narrow slit was left in the wall through which the male fed his mate throughout the incubation and nestling period. The male offered berries, regurgitated one by one

Table 1: Details of Narcondam hornbill nests recorded during March 2000

Nest	Date	Altitude (m)	Tree (Local name)	Slope Face	Nest opening	Nest Height (m)	App. Tree Height (m)
1	10.03	105	Thipok	East	East	12	30
2	11.03	120	Lattoo	West	South-west	15	28
3	13.03	95	Thipok	West	North-west	30	39
4	13.03	80	Thipok	West	South-west	10	28
5	15.03	490	Thipok	West	North-west	17	28
6	17.03	55	?	East	South-west	12	28
7	17.03	55	Thipok	West	West	35	39
8	19.03	35	?	West	Vertically upward	30	41
9	19.03	125	Dhoop	East	North	13	30
10	20.03	90	Mahua	South-east	South	20	32
11	21.03	645	Jaiphal	South-west	South-west	18	30
12	23.03	255	Jaiphal	East	North	5	25
13	23.03	245	Mahua	South-east	South-east	14	18
14	24.03	95	Dhoop	South-west	East	18	30
15	24.03	110	Mahua	North-west	West	28	34
16	25.03	160	Kali Lakri	East	West	10	27
17	25.03	190	Kali Lakri	South	North	11	27
18	26.03	80	Thipok	North-west	South	13	28
19	26.03	98	Lattoo	South-west	South-west	25	29
20	26.03	110	Lattoo	South	South	20	29

and shifted up to his bill-tip, to the female who passed it on to the young. Older nestlings may receive food directly from the male, but this was not clearly visible.

The Narcondam hornbill is mainly frugivorous like other hornbill species and has a regular daily feeding schedule. Nest feeding started at 0440 hrs and the last feeding was recorded at 1705 hrs. Fig. 3 shows the average number of feeding visits made by the male on Nest Nos. 1, 2 and 3. On an average, the male made 2.5 visits per hour. No feeding was observed during heavy rain, as the wet male had to cling strenuously on to the nest to feed the nestling and female. Invariably maximum feeding was done during morning hours (Fig. 3).

Food of the hornbill mostly constitutes of large drupes, wild fig, and berries; also insects, lizards and small animals. Nine species of fruits were identified: *Caryota mitis*, *Mystica andamanica*, *Artocarpus chaplasha*, *Delinea indica*, *Sideroxylon longipetiolatum*, *Ficus scandens*, *F. glomerata*, an unidentified *Ficus* species and *Syzigium cuminii*.

Number of insertions per visit by the male varied with the size of the fruit, 2-77 insertions were recorded on Nest No. 1. However, mean numbers of insertions was x = 23.5 ±18.7, n = 32. Similarly, on Nest No. 2, 1-40 insertions per visit were recorded, while mean number of fruits fed was x = 15.4 ±11.6, n = 32.

Total time spent by the males on Nest No. 1 ranged between 1 and 11 minutes. However, the mean time spent per visit was x = 15.4 ±4.37, n = 32. Similarly, the range of total time spent on Nest No. 2 was from 0.5 to 7 min, while mean time spent was x = 2.81 ±1.6, n = 32. Once the feeding was over, the male would clean its beak on the branch a few times, and often preen for a while before flying away.

Interactions with other species: On three occasions, we observed 4-5 hornbills mobbing the white-bellied sea-eagle *Haliaeetus leucogaster* and chasing it from tree to tree. No apparent inter- or intra-specific competition for nesting sites was recorded. Alexandrine

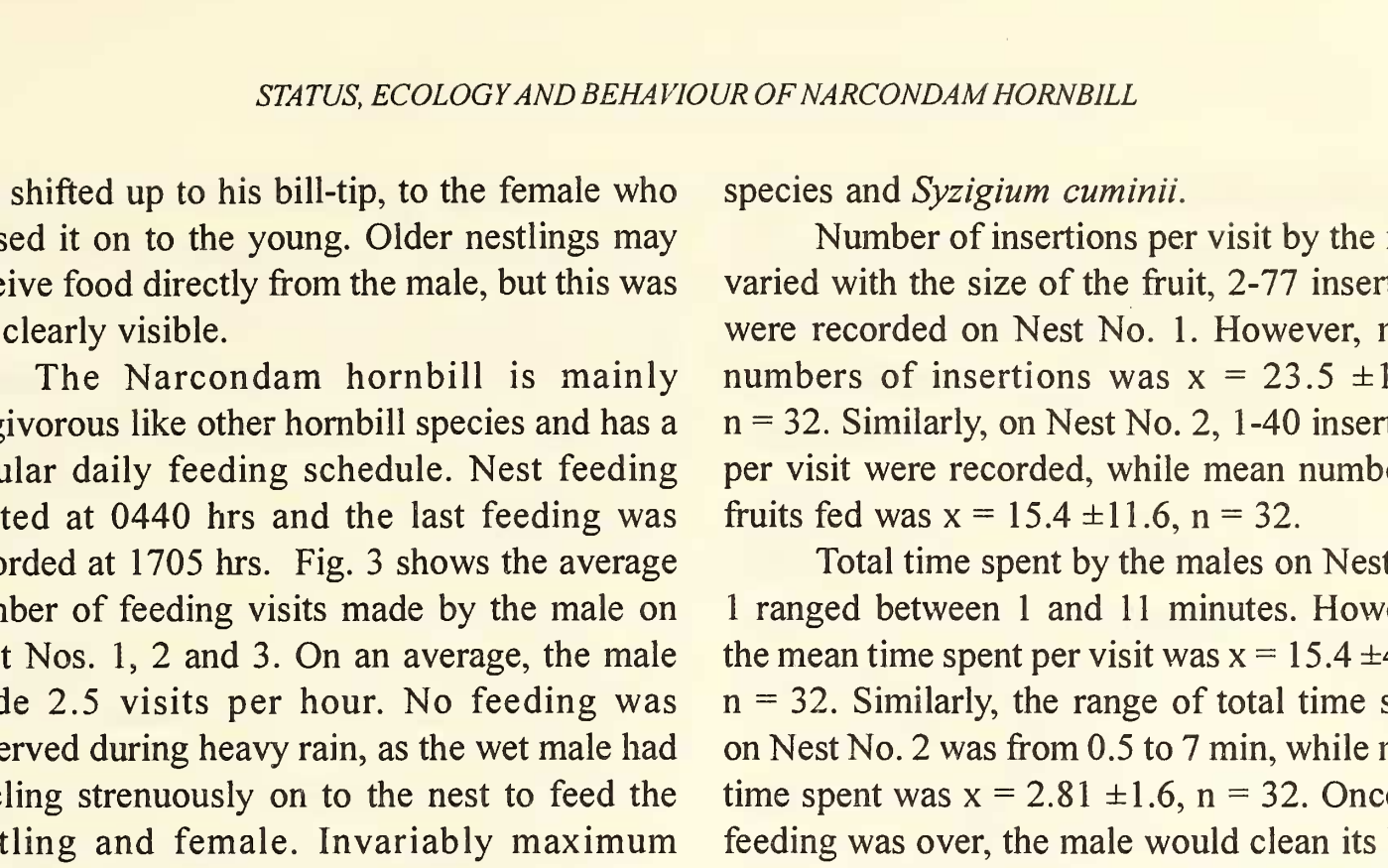

Fig. 3: Feeding visits of male Narcondam hornbill in nest during different time of the day (n=3 days/nest)

parakeets and common hill-myna (*Gracula religiosa*) were recorded nesting on the same tree as the hornbills. We did not notice any predators. Once a hawk (unidentified species) was observed soaring in the sky. However, considering its small size, it did not appear to pose any threat to the hornbills.

Feeding in group: While breeding pairs were recorded feeding and collecting foods largely individually or in groups of 2-3 birds, large flocks up to 50 non-breeding birds were regularly noted feeding, displaying or flying together up and down the valley. The composition of such feeding flocks is given in Table 2. They were recorded almost throughout the day, but were larger, more noisy and active during late afternoons while preparing to roost.

Fighting, chasing, billing, calling and preening were the common activities during feeding and foraging. At times, two or more in the group would fly up in the air, move in the group, move zigzag up to about 100 m and then descend. Similar acrobatics were performed during pre-roosting and post-roosting activities. While feeding in groups on the fruiting trees at times, some were seen descending on the bush and even catching insects, often as low as 1 m above the ground. However, the breeding males were recorded searching for insects more than the non-breeding birds. Larger congregations on fruit-laden trees (mainly *Ficus* spp.) were observed almost every evening before roosting. Congregations of 4-5 breeding males were also observed occasionally, at times other than

Table 2: Activity and flock composition of Narcondam hornbill during March 2000

S.N.	Time of observation			Total	Male	Female	Activity
	Start	End	Total (min)				
1	1650	1726	36	32	19	13	Calling, preening, hoping
2	0510	0543	33	15	08	07	Feeding & displays
3	1200	-	-	04	02	02	Flight
4	1437	1500	23	14	05	09	Actively feeding
5	1645	1705	20	50	24	26	Pre-roosting displays
6	1103	1121	18	04	03	01	Feeding actively
7	0600	0645	45	06	05	01	Feeding & aerial displays
8	0725	0728	03	04	02	02	Aerial displays
9	1517	1529	12	05	02	03	Active calling & feeding
10	0940	0945	05	04	-	-	Flight
11	1610	1700	50	37	19	18	Pre-roosting activities
12	1615	1633	08	05	02	03	-do-
13	1530	1610	40	06	-	-	Acrobatics & Feeding
14	1530	1700	90	22	14	08	-do-
15	1612	1620	08	05	03	02	Mobbing white-bellied sea-eagle
16	0615	0620	05	07	-	-	-do-
17	1215	1230	15	19	-	-	Aerial movements
18	1515	1542	37	19	10	09	Feeding & Acrobatics
19	0542	0724	96	18	-	-	-do-
20	0905	0910	10	06	-	-	Flight
21	1150	1203	13	11	05	06	Active feeding
22	0545	0630	45	48	22	26	Feeding & Acrobatics
23	1340	1445	65	16	09	07	Feeding & Calling
24	0900	0910	10	18	-	-	Feeding & Resting
25	1600	1630	30	34	20	14	Pre-roosting activities
26	1500	1620	80	22	12	10	Pre-roosting activities
27	0555	0558	03	04	02	02	Acrobatics

feeding. On two such occasions, the males were recorded mobbing and chasing white-bellied sea-eagles from their nests.

Pre-roosting Behaviour: The roosting pattern in the Narcondam hornbill appears to be "generally bird-like", settling in the evening at the approach of dark, and emerging early in the morning. They roost in the foliage of the tree, in groups, at a particular site. Pre-roosting activities of non-breeding flock were recorded every day. During this study, a flock of about 50 birds (mainly non-breeding) was followed for 20 days, one hour before settling time and one and a half hours after they emerged from the roost.

Pre-roosting activity of the non-breeding flock consists of loud calls, chase of members and acrobatics. Such flocks comprised of several males and females, all moving in a semi-circular direction, from branch to branch and tree to tree, at times alighting on low bushes. Feeding during this period was noted to be very brief. At times, they perched on foliage one on each top branch, calling and preening alternately. The number of birds in such flocks varied from 4 to 50 on different days (Table 2). Pre-roosting activities start around 1600 hrs and lasted up to sunset. At dusk, all birds would become quiet and leave the foraging area in groups of 2, 3 or 4, all following the same route southwest of the camp.

The most interesting pre-roosting behaviour was the performance of acrobatics in which one bird would fly high up in the sky and then drop down haphazardly and zigzag. These performances were reminiscent of the displays of pigeons and doves, but while these select particular branches to initiate the display and return to almost the same perch, the Narcondam hornbill acrobatics were less organized. The pre-roosting activities of the breeding pairs were not very pronounced. While the females remained inside the nest holes, the males kept feeding them and the young until quite dark and then after the last feeding moved to a nearby thick foliage.

Post-roosting activities: Post-roosting activities were less pronounced in the hornbills. After emerging one by one from the roost, the birds rushed to nearby trees and started feeding in small flocks. However, on overcast mornings or after moderate rains the birds were noted performing prolonged aerial dynamics as recorded in the afternoons. During cloudy and drizzle mornings, play behaviour of males and females on fruiting trees was recorded to be more elaborate. The first feeding in the morning lasted about 15-20 minutes and then suddenly the whole group would move in other directions one by one.

The breeding males were observed to collect food immediately after emerging from their roost and rushing to their nest. The first feeding was recorded as early as 0440 hrs. No siesta was recorded during day hours. However, some birds especially the breeding males were recorded resting on exposed branches, preening and calling at times between two nest feedings in the hotter hours of the day.

Calls and Vocalization: The call of the hornbill is a trisyllabic *"qua qua qua"*. While hopping and feeding on the fruit trees, it calls *"quank quank"* repeating about 100 calls/minute. Similar calls were noted in non-breeding males during display. At times, calling symphony of two hornbills was observed. Two males perched on nearby trees called up to 5 minutes at a stretch, responding *'qua'* to each other. Since these calls were heard near nesting trees, they could be territorial calls. Flock of non-breeding young hornbills, called loudly during pre- and post-roosting activities.

The hornbill was noted to be the most vociferous bird on the Island, invariably uttering loud shrill calls at all occasions. Most of these calls were found to be associated with maintaining the flock together. Territorial calls by breeding males were quite pronounced, and very helpful in locating their whereabouts and nests. While carrying food to the nest, the male starts calling from about 100-150 m away from the nest, until it arrives to the nesting trees.

Females incubating / brooding inside the nest often responded to these calls with less noisy croaking. When disturbed, a fast and repetitive series of trumpeting sounds is uttered. These calls were faint "*qua qua*" in low tempo, audible up to about 50 m from the nest. These calls were made in response to calls of males or to induce him to bring more food.

Once a hornbill and a koel were observed calling in competition with each other. The hornbill called "*qua qua qua*" three times, while the koel responded with three "*ki ki kik*" almost simultaneously and continued doing so for about 1.5 minutes. In flight, adult birds continuously call '*ka .. ka .. ka*'. The female inside the nest is generally silent, but some times utters a single '*krwak*' if the male is late in offering the next berry. The male, when alarmed, calls a halting '*ko .. kokokoko ..ko ..kok .. ko*', while the female, when alarmed, emits repeated '*ktaawk kok kok*' similar to the alarm calls of the domestic fowl (Hussain 1984). Males do not react to human disturbance close to the nesting tree.

Food begging calls of the chicks: Begging calls for food was often heard near the nests. The male brings food near the nest, calling loudly until it finally perches on the outer rim of the nest. The chicks keep calling '*chew . . . chew . . . chew*', continuously, like a sewing machine in operation, until they are fed.

At times the chick can be heard calling, even when the male is away. Although spotting a nest in the presence of the highly vocal male is easier, chick calls facilitate the process. We located three nests by hearing such chick calls. The chicks also make soft *kee kee kee* ... calls on the approach of the male with food.

Discussion

In the past 400 years, 93% of the species and subspecies of birds that have become extinct have been island forms (King 1981). Most of these were due to loss of habitat, smaller population size, competition, predation, disease or other catastrophes. Population regulation factors become crucial for endemic species like the Narcondam hornbill, since the Island size is very small. Competition for nesting cavities and food may also affect the hornbill population on the Island. During our study, five different hole nesting species of birds were recorded breeding.

No predator of the hornbill has been recorded so far on the Island. Water monitor, the only large reptile on the Island is known for its egg stealing habits (Daniel 1983), and thus may be possible predators. Hussain (1984) reported a flying snake just near the hornbill nest. Mobbing of koel and white-bellied sea-eagle by the hornbill has also been reported earlier.

The avifauna of Narcondam is not very rich compared to any other moist deciduous and tropical forest. The most obvious limiting factor is the oceanic barrier and the Island's remoteness. The nearest island is the North Andaman. The Coco Island of Myanmar is about 96 km, while the contiguous forested islands of Diglipur and Mayabundar (North and Middle Andaman) are also quite far. Bird life even in these forests is sparse.

From the density figures obtained, the Narcondam hornbill is surely not facing any danger of extinction, but is vulnerable due to confinement and isolation. The population seems to be stable at present. However, their status and population should be constantly monitored and disturbance to the Island should be minimized.

The nest site selection by the hornbills may depend on characteristics of nest cavity and of the surrounding habitats (Klop *et al.* 2000). Natural cavities are used by most species although some smaller species may use old barbet or woodpecker holes (Kemp 1976). Once a suitable hole is selected, the entrance is plastered with sticky materials (e.g. mud, feces, wood shavings, saliva, fruit pulp, etc.) until no more than a narrow slit is left open.

During our study we found no particular preference in nest cavity selection, but more nests were seen on east and west facing slopes, depending mainly on the availability of the cavities. However, Muddapa (2000) has reported preference for northeast aspect in case of Malabar grey hornbill (*Ocyceros griseus*). The nest site selection in general may depend on other factors like height of nest, cover, surrounding habitat, slopes, nearness of fruiting trees and disturbance factors. Nests facing east or west may get more sun light, which would be helpful in keeping the nest hygienic and the female/nestlings healthy.

Nests of the hornbill were recorded wide apart and in different areas from shore to the summit. Such a nesting pattern has been described as anti-predatory strategy between neighbours (Klop *et al.* 2000). The kind of spacing, although, is the result of several intrinsic and extrinsic factors.

Tree density

From the results, the density of nesting and fruiting trees looks quite favorable for the present population of hornbills. The occurrence of such a high tree density is feature of the tropical moist forest ecosystem. Thus, the habitat is highly suitable for species like the hornbills, which require adequate nesting cavities in every breeding season.

Breeding cycle

The breeding cycle of the Narcondam hornbill is synchronous with food productivity of forest (i.e., fruiting phenology). Like most other bird species, hornbills are mainly fruigivorus. They exhibit wide-ranging movements to meet their specialized food requirements (Poonswad 1995). Functionally, they have been described as keystone naturalists (Gilbert 1980) as they play an important role in the dispersal of many rare rainforest tree species (Kinnard 1998, Whitney et *al.* 1998).

Food

We identified nine species of fruits being fed by the male during this study, while Kannan and James (1997) reported 15 species of fruits fed by the great pied hornbill (*Buceros bicornis*). In wreathed hornbill (*Aceros undulatus*) and the Oriental pied hornbill (*Anthracoceros albirostris*) Dutta (2000) has reported 51 plant species exploited and dispersed by the hornbills. Insect food in the breeding time may be because of the increased demand of calcium or animal proteins for the faster growth of the juveniles.

Though we represented data on mean number of time spent on the nests, sometimes the bird spent exceptionally long time near the nest, but such visit data has not been included for calculations and the values were treated as outliers.

Mobbing of the predators seems to be a common phenomenon and has been reported earlier (Abdulali 1976). Though eagles are unable to catch the nestling, they may be potential predators to fledglings and probably due to this reason the hornbills are hostile to the eagles. The water monitor lizard (*Varanus salvator*) may rob female and young from the nests. However, as pointed out in case of the Malabar grey hornbill (*Tockus griseus*) by Muddapa (2000), such possibilities are remote.

Narcondam hornbills did not show any obvious inter- or intra-specific competition for nesting and feeding resources due to the availability of adequate number of nesting trees and fruit species on the Island. However, this study started after the pairs had mostly settled for nesting. Such competition might have existed in the initial stages of nest site selection.

Like barbets (*Megalaima* spp.) and many other birds (Yahya 1987, 1990) hornbills follow a regular pattern of pre and post-roosting activities. They congregate at sunset flying high in irregular follow my leader style over fixed routes for roosting in selected patches of giant bamboo or thinly foliaged trees (Ali and Ripley 1983).

Recommendations

1) There should be no further expansion of the camp and a meterological sub-unit should be maintained with the available staff to keep track of the physical environment. The vegetation structure and composition of the Island should be studied properly. Research on the habitat requirement, breeding success and behaviour is important for the rational management of this endemic species.
2) Hussain (1984) suggested captive breeding and introduction of the species on to some ecologically similar nearby and uninhabited island. We support his idea of introduction, as giving an alternate home may bring additional security for this isolated species.
3) Most of the introduced goats, which were a serious problem on the Island have been removed recently. Still one can see groups of three to four feral goats near the campsite or else where occasionally, and should be removed immediately.

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